THz LASER Using High-T_c Superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ Mesa Structures

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Discovery [1] of coherent electromagnetic wave emission at terahertz frequencies from a mesa structure made of high-T_c superconducting $Bi_2Sr_2CaCu_2O_{8+\delta}$ single crystals has triggered intensive researches in both fundamental and applied sciences, since it can be used not only for the fundamental physics but also for the wide variety of applications such as medical diagnostics, nondestructive inspections, high speed communications, imaging technologies for security and defense, quantum electronics, *etc*. We have studied many cases where the geometrical shapes of mesas are changed from a standard rectangle to a cylinder, a triangle, a square, *etc*. As results the emission frequency is determined by the ac-Josephson relation precisely, *i.e*., it follows the relation $f_J=2eV_N/h$, where V_N is the voltage appearing between the electrodes of the mesa. It turns out that the shape is also important and works a cavity resonator of the electromagnetic waves. The stronger emission can be obtained by tuning f_J to one of the cavity resonance frequencies. Using the inner branches of the *I-V* curve f_J can be varied widely from ~0.3 to 1 THz. Using high power emitter (~100 mW) a prototype imaging set-up has been constructed. The results will be shown.

[1] L. Ozyuzer *et al*., Science **318**, 1291 (2007)

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